An Advanced Dynamic Optimized Routing (DOR) Protocol Based on Clustering for WSN to Enhance Energy Efficiency

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Abstract

A "Wireless Sensor Network (WSN)" was a self-configurable group of spatially dispersed and dedicated "Sensor Nodes (SNs)", which can sense, process, and communicate among themselves using radio signals. The data sensed from various SNs are routed to the distant sink node will reduce the energy level of the intermediate SNs, which constitutes the primary issue in the WSN that degrades the network's performance significantly. Cluster-based routing is one of the approaches in this area for efficient usage of energy in WSNs. In WSNs the routing path needs to be reliable and persistent, especially in multi-hop communication. The SNs along the selected routing path exhaust their energy rapidly due to the frequent exchange of messages. In these circumstances, when the discovered routing path and the fixed "Cluster Head (CH)" is disconnected due to energy depletion, the cluster-based routing mechanism must reconstruct the routing path. This reconstruction might lead to additional energy consumption for SNs, which reduces the energy level of the SNs. Hence, an optimized routing mechanism is required for efficient and reliable communication in the WSN. A novel "DynamicOptimizedRouting (DOR)" protocol has been proposed in this paper for WSN by dynamically selecting the "Cluster Heads (CHs)" in a rotation period based on their "Residual Energy (RE)" from the "Cluster Region (CR)". Through the proposed DOR protocol the SNs sense the information from various context and transmits the information to the sink node using the temporary CHs with higher energy dynamically. This efficiently minimizes the number of explicit control packets and also reconstructs the routing path in the path damage scenario. Thus it maximizes the "Packet Delivery Ratio (PDR)" and the "Energy Efficiency (EE)" of the network by selecting the efficient path from the source SN to the sink node. We compare and analyze the performance of the proposed DOR protocol with the existing E-BEENISH protocol with network parameters such as "Energy-Efficiency","Packet-Delivery-Ratio", "Throughput", and "Routing-Overhead" in the WSN.

Keywords: *WSN, Energy Efficiency, Clustering, Dynamic Optimized Routing, Residual Energy*
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1. Introduction

Sensor technological improvements in the last several years have made it possible to transmit measured data remotely to a target region. Wireless methodologies are used to send the observed data across great ranges as electrical signals [1]. Through the employment of thousands of wireless detecting devices, known as SNs, with a definitive objective, a structure is formed termed WSN may be created. A sensor network's primary goal is to gather significant environmental data in a specific region and deliver it to a "Base Station (BS)" or "Sink Node" for further analysis [2].

Those WSNs have been constructed from a considerable range of limited SNs that have been linked together via low-power wireless technology. A sensor network has been completely distinct from a group of sensors in that it enables interaction, synchronization, and engagement among sensor elements via its networking capacity. Taking use of improvements in nano-devices, remote sensing, wireless technology, and networks during the last decade. Human lifestyles will be significantly impacted by the WSN technologies in the 21st era [3].

Such WSNs, in contrast to controlled networks, operate on an as-needed basis. WSN is defined by its self-configuring and self-healing properties. With this, they have an enormous edge in a wide range of scenarios. There are a lot of "exciting and innovative" applications that may be developed using this appealing network's flexibility, ease of implementation, and customization.

WSN sensors typically use batteries as their power source and trying to charge or replace those batteries would not be a possibility in most situations. Transmission of data in a WSN, on the other hand, uses a lot of power. To ensure that WSNs can gather and transmit the data for a long period, it is necessary to address the issue of energy efficiency [4].

Using the Clustering technique, WSNs may be made more energy efficient by balancing the amount of energy each SN consumes. Sensors are grouped in this configuration based on predetermined characteristics [5]. The "Cluster Members" (CMs) provide their data to the CH nodes, which in turn transfer it to the Sink Node or the BS. It's difficult to choose a CH from amongst all of the SNs in a given cluster. It is the responsibility of the CH to gather the data from all nodes in the network and transfer it to the sink or BS [6]. A particular SN cannot maintain the CH function permanently due to the high energy requirements. CHs must be replaced at the right period, hence it is vital to do so.

Sensors near the BS may be used as relays in stable situations. As a result, the CHs close to the target use a lot of energy, which causes the sensors to suffer from power shortages. For this reason, the rotation technique is widely accepted as a viable solution [7].

Problem statement: CHs generally spend higher energy than CMs in cluster-based routing systems. The energy imbalance in WSNs is caused by the inequitable use of energy by SNs. Cluster routing has a challenge with this [8]. The Cluster routing poses 2 major difficulties. In the first place, it is challenging to build an ideal CH selection that considers both energy utilization and communication overhead at the same time. Second, calculating the mobile BS's relatively short routing path is difficult. For the majority of decentralized cluster routing algorithms, every SN is required to acquire data from all other SNs in an attempt to build network routing [9]. In addition, SNs are used to compute the routing. If the network is wide, an edge SN that employs a decentralized routing mechanism will have a difficult time locating the route to the BS. In an attempt to initiate the connection with the BS, SNs among a big network needs additional control messages. Because of this, current decentralized routing methods require additional routing costs and calculation overhead for SNs during the routing initialization stage [10].

Contribution: In this article, an innovative DOR technique for enhancing WSN energy efficiency centered on clustering has been proposed that may be used for recurring data collection purposes. The structure is divided into CRs, with a particular CH within every CR, using this strategy. Through this strategy, the CH may interact with the BS effectively. During the network implementation stage, the SNs inside the cluster acknowledge the "hello" message broadcast from its BS at a specific level of power, establishing their existence and distance from it. For instance, it allows the SNs to calculate an estimated distance from their position to the BS using the RE that was sent back to them. The SN can identify the correct level of power for interacting with the BS using this signal calculation. There are 3 parts to the process as stated in this: First, the CH is chosen, then the cluster is formed, and last, the data is transmitted. The system chooses distributed CHs with low control transparency throughout the CH selection procedure. The SNs underneath the CH are gathered together via the creation of cluster processes.

Paper Organization: Section 2 covers the recent publication on energy efficient protocols for WSN, Section 3 briefs about the methodologies module by a module for each existing and proposed protocol, and Section 4 discusses the results obtained from both existing and proposed protocols with its comparison, and Section 5 finally concludes this research article with future scope.

2. Related Works

The "Mobile Sink-Selective Path-Priority Table (MSPT)" method was developed by the researchers in [11]. To keep the network running for a suitable amount of time, it balances the energy utilization of WSNs. CH choosing is conducted during the initial step of the MSPT technique, which includes two steps. By picking two SNs that are nearest to them in the cluster, the SNs adopt an alternate route for themselves in the second step of the process. A "Priority Table (PT)" costs are calculated using the total amount of energy, range of values for energy, energy proportion, and percentage attributes. The computed PT levels are placed further into a matrix, and also the route feedback with the lowest PT level is chosen in the third step of this process. The paper's main downfall, therefore, is that it doesn't explain how clusters and CH choices have been determined.

Re-selecting CH was proposed based on conditions stipulated by the researchers in [12]. For each CH in the trip, a RE is computed and a threshold level is taken against which it is compared. The CH is re-selected if it falls below the predefined threshold. In contrast, single-hop transmission is assumed by "IoT LEACH (I-LEACH)". Due to the enormous distance among both CHs and BS in large-scale WSNs, the amount of energy required to transmit data to the BS is significant. As a result, CHs utilize energy at a faster rate.

According to the researchers in [13], their designed "Energy-Efficient Scalable Routing Algorithm (EESRA)" has a 3-layered hierarchy framework that intends to lessen the strain on CHs. The LEACH protocol's randomized picking is utilized to pick the cluster during the initialization stage. Clusters have been formed following the selection of the CH. Two or maybe more "Cluster Congregations (CGs)" may be selected by each CH. The CG's job is to gather information from the CMs and provide it to the CH for analysis. During the steady-state stage, the CMs use "Carrier-Sense Multiple Access with Collision Avoidance" to communicate the information they perceived to the CG. The CG transmits the acquired information to the CH via TDMA to conclude the route. Energy efficiency is improved by the suggested strategy based on the findings of this research article.

Clustering depending on "Fuzzy C-Means (FCM)" and "Differential Evolution" was suggested by the researchers in [14]. The BS performs the clustering mechanism. SNs will not be able to use energy for clustering as a result of this. The appropriate number of clusters in the network is calculated using the FCM method, and this results in a load-balanced cluster. Every SN's evolutionary process determines the most suitable SN, which is CH. Consequently, a large-scale network's lifespan and usefulness are constrained by single-hop communication and a constant BS.

The "RE based LEACH (R-LEACH)" protocol developed by the researchers in [15] is a two-step hierarchical clustering approach. The initial energy in their proposed structure tries to pick the CH while considering critical characteristics like the RE of the particular SN and the optimum numbers of CHs throughout the network into consideration. The LEACH method is used to build CHs and clusters during the initialization stage. The fresh CH is determined depending on the RE of the leftover SNs after the round. Data is sent to the CH at the designated time for each SN, in the steady-state phase. All cluster nodes have completed sending data, and now the CH is responsible for processing and sending the data back to the BS through one or more hops. Increasing inter-cluster distances may occur in large-scale WSNs. The SNs' energy usage may increase in this scenario.

3. Methodologies

3.1. Formation of a Cluster and its Rotation

Considering WSN has a wide range of applications in a variety of sectors and domains. If WSN is to be effectively managed, it must be tackled from the very root. The SNs may have a longer lifetime when clustering is used as a management tool. Dynamically, SNs group together, and the cluster that forms undergoes periodic rearrangement. There is a specified originator for each period and the information has been transmitted using the techniques outlined before for cluster organization. The multi-hop broadcasting strategy is used in an attempt to lower the amount of energy required. Because of this, the SNs do not have to communicate with each other individually. Compared to past broadcasting methods, that seems to have a major disadvantage: a longer delay period we intend to overcome this with the proposed method. In the following sections, we brief each module separately.

3.1.1. Choosing and Rotating the CHs

After the construction of clusters, the very next stage is to pick an individual SN from CM to serve as the CH. Data aggregation and routing from CMs to the BS are the responsibility of CHs. The CH's workload is directly proportionate to the cluster's size. Generally, the CH was selected at random or assigned by the network's developer.

Another factor in choosing a CH is the RE of the SNs. The CH responsibility is rotated across its member's SNs to equalize the workload on the CHs, hence increasing the usable lifespan of such clusters. A "Random Selection" approach is used to randomly choose a CH. The CH is selected based on the chance that the SN has never been voted as CH over its overall network lifespan. While the cluster's SNs rotate the function of CH, a particular SN is no longer burdened with this obligation. In a rotating process, a new CH is chosen at regular intervals. The SN with the most energy is selected as the CH in the RE formulation of CH. The SN keeps the CH designation until its energy value drops below the average of the whole cluster. As a result of the CHs rotating, the SN's total energy will then be distributed evenly. The network's lifespan may be extended by selecting CH at the maximum energy level. It is possible to pick the CH depending on the distance between it and other CMs.

This method, on the other hand, offers a reduction in energy consumption during the transfer of data to the BS. Using this technique, the CH is placed as close as possible to the other SNs in the cluster, to lower the communication's energy usage. The amount of energy needed to transmit information in WSNs is a significant factor, and it can be simply shown that the amount of energy spent primarily relies on the proximity between its SNs. Such that the SN may send information to BS through this specific CH, it is selected so that the distance between it and any other clustered SN stays lower than any other CH.

3.1.2. Optimizing Clusters

Whenever the issue of energy usage in WSN is being addressed, hierarchical networking examines the cluster size as an essential aspect. Smaller clusters may not experience significant energy loss through intra-cluster connectivity, however, the network's foundation architecture will be compromised. Whereas if the size of the cluster stays modest, the network encounters moderate loads, however, the energy usage during intra-cluster transmission is considerable and the lifespan is significantly decreased. Cluster formation must be balanced against these considerations.

A multitude of approaches has already been put forward in an attempt to minimize the amount of energy used in communication. Through one scenario, an SN may cut down the number of hops it needs to communicate with its CH. Communication energy usage is directly linked to distance amongst the SNs that interact, as described above. For example, an SN which might be situated near to the BS spends lesser energy in sending the information than an SN that has been located distant from the BS.

Apart from its position within a cluster, other factors that influence how much energy is used in a cluster include its size and accessibility to the BS. Every time a network's original design is made, a new cluster's size is completely random. As a result, there is always an unequal distribution of data flow inside and among SNs inside the clusters. However, in other cases, the number of SNs throughout all clusters is identical, implying that the cluster sizes are equal. Clusters located near the BS experience more energy loss than clusters located farther away from the BS in such cases.

3.2. Protocols for Energy Efficiency

3.2.1. E-BEENISH

A routing protocol called "Enhanced Balanced Energy Efficient Network Integrated Super-Heterogeneous (E-BEENISH)" currently existed. As a result of this, a wide variety of energy states in heterogeneous WSNs are taken into consideration when calculating transmission energy usage. Depending on the volume of energy left over and the range between each SN and the sink node, it uses weighted voting probability with every SN of becoming a CH.

Process of E-BEENISH

- They devise a technique that takes into account the distance between the SN and the sink node in an attempt to circumvent the basic BEENISH protocol's threshold determination.
- The issue of the node distant from the BS dying prematurely as a result of its energy use is made worse when such a node serves as the CH.
- In an attempt to prevent the ping-pong impact, they design a selection of CHs that takes into account the network's overall energy and range parameter, and also the RE.
- Additionally, they created a normalized weighting variable to significantly enhance the network lifetime and redistribute energy and the part of a range inside the threshold architecture more effectively.

E-BEENISH Disadvantages:

- The key drawback of the algorithm is that it searches randomly by taking a lot of time to spend on available resources.
- The next drawback is that the rotation of higher energy SN can't be treated as CH. This refers to a cyclic structure and the optimal path most frequently can not be reached.

3.2.2. Clustering Based Dynamic Optimized Routing (DOR) Protocol

This proposed DOR protocol for WSNs is detailed in this section that can be employed for recurring data collection purposes. The structure is divided into CRs, with a particular CH within every CR, using this strategy. Through this strategy, the CH may interact with the BS effectively. During the network implementation stage, the SNs inside the cluster acknowledge the "hello" message broadcast from its BS at a specific level of power, establishing their existence and distance from it. For instance, it allows the SNs to calculate an estimated distance from their position to the BS using the RE that was sent back to them. The SN can identify the correct level of power for interacting with the BS using this signal calculation. There are 3 parts to the process as stated in this: First, the CH is chosen, then the cluster is formed, and last, the data is transmitted. The system chooses distributed CHs with low control transparency throughout the CH selection procedure. The SNs underneath the CH are gathered together via the creation of cluster processes. Figure 1 shows how the systems are divided into clusters.

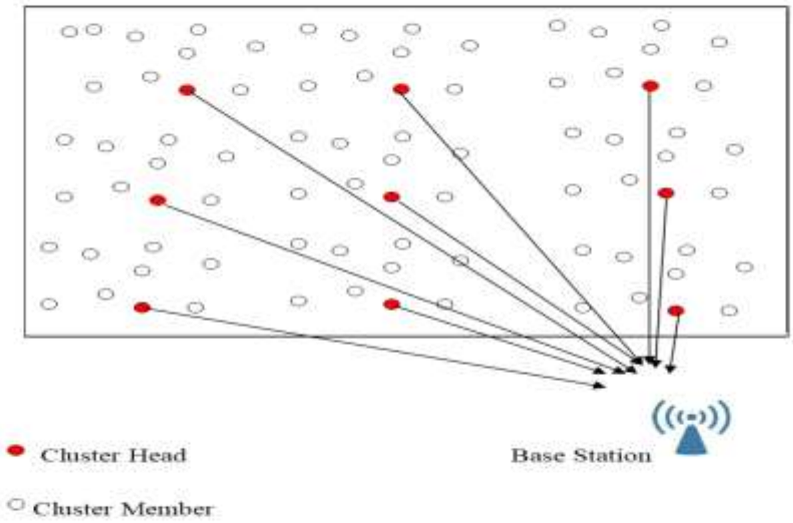

Figure 1. System grouping based on clusters

(i) Selection of CH

The CH is selected at this moment, and the group is then structured by gathering the SNs.

Cluster Region

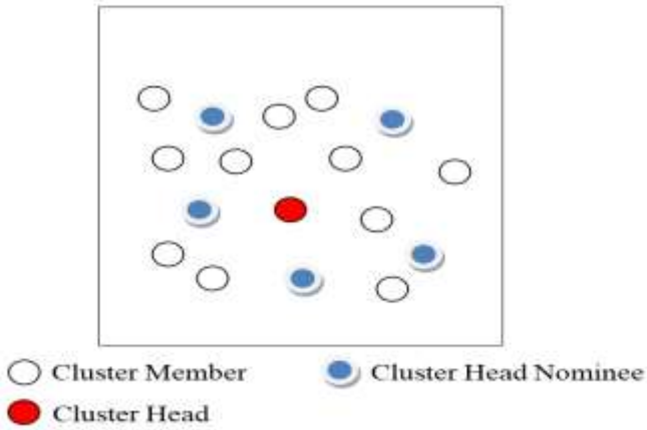

Figure 2. Cluster Region

CH automatically rotated to a different SN in the cluster when its energy level falls below the median level of energy of the cluster. Figure 2 illustrates how the CH cycle may be used to split the system into CRs.

Each CR assigns a confidence level to the SNs involved in CH selection, and those SNs are referred to as "CH-Nominees (CHN)". Every SN decides whether or not to become a CHN based on this value.For the most part, the probability that an SN will turn into a CH is "U".A SN "j" in "Region (R)" has a chance of forming based on Equation (1):

$$Q_j = U\frac{\text{Residual Node Energy}}{\text{AverageResidual Energy}} \quad \text{Eq}\rightarrow 1$$

A single computation of "Qj" is carried out once the network's startup has occurred.In the beginning, all of the CR's SNs choose a randomized value between [0 and 1].Whereas if the value specified is lower than "Qj", an SN would become a CHN.CHNs are therefore selected from among the CR's roughly S-to-1 ratio of SNs.

Though the mechanism helps in identifying the potential CHN, it requires each SN to broadcast its energy value to all othersin its CR, which is certainly a high message overhead.As an alternative, a central SN in each CR receives the levels of energy from the other SNs in the area and distributes the average to every SNs throughout the region. Despite this, the network is burdened with the extra task of selecting and replacing the SN central. Counters during every SN could be leveraged to maintain a count of how many times an SN has been CH during a certain duration. However, this also entails subsequent agreements amongst SNs.

To overcome the above constraints this proposed method uses the original levels of energy to choose the CHNs which could address all of these concerns. Because the frequency at which the CHN is chosen is proportional to the starting level of energy, and since the resulting CHs are finally picked from among these CHNs, this will be the scenario. A node's CH function and later energy usage levels are therefore on an equitable basis concerning SN's starting levels of energy usage. Thus, this strategy may be used to ensure that energy usage levels are balanced while avoiding unnecessary costs.

For each CHN that has been designated as such in the "CLRj," the CR sends a "CH Advertisement (CHAD)" packet that contains the values of RE levels in the vicinity of a specific "Radius (rj)" as determined by Equation (2).

$$r_j = \sqrt{\frac{mx}{\pi Q_j}}$$

Eq→2

When it gets advertising from another CHN with a greater energy level than its own, the CHN stops operating as a CH and examines its level of energy. In the end, the CHNs with the highest RE among their surrounding CHNs get to be the CHs. If a CHN somehow doesn't obtain any advertising packets for a duration of time, this would effectively get to be a CH node but also waiting for the "Q" wait time. As a result, the system makes it easier to choose certain CH SNs.

(ii) Formation of Clusters

The chosen CH transmits a "CH Announcement" packet to all of the other SNs inside the CR, announcing their selection through the "Radius (rj)" region of transmission. A multiple of "rj" has been the range for CH announcements. To make sure that the announcements have reached all the available SNs within the CR, a simple method of region-wide broadcastscan be performed. But, this has a certain limitation of broadcast energy cost ishigh; so a fine tuned rate is necessary. As a result, a system bound rate isrefrained to achieve high "CH-Association probability for Non-CHs" and at the same time evading a needless large transmission range.

Every CM node that lies between multiple CRs mightreceive announcement packets from multiple CHs, in such cases, the SN selects its CH based on the RSSI value of the announcement packetreceived from the CH and decides the ideal CH to get associated with.

To get associated withCHs the SNs send a “CH joiningrequest" and associates only after receiving a subsequent “CH confirmation”, possibilities are that there may be a small number of SNs that have notrelated with any clusters at the end of the cluster formation phase as theymight not have obtained any notice packets. To conquer such situations,anSN that has not related to any CH slowly increases its transmissionrange and tries to find the closest CH associated with it.

During the second phase, the "Time Division Multiple Access (TDMA)" schedule is broadcasted by each CH within its cluster. Upon receiving, the members ensure to processin the equivalent time slot and to save energy further it turns off the radio inthe idle time. Furthermore, the BS often coordinatesevery SNs above the system associated with the time drift.

Take the WSN of "M (SNs)" as an example, where "MS (SNs)" advertise as CHNs and generate a maximum of "MS messages". In the end, "L (CH)" nodes are selected, with a sum of "L announcements" for CH communications, that proclaim their position as a CH. Following that, the SNs select a certain CH to participate and issue CH-association requests, incurring an extra cost of M-L. Each request results in the generation of a CH-confirmation message. Thus, as shown in Equation (3), the total message complexity in the construction of clusters is essential as follows:

$$MS + L + 2(M - L) = (2 + S)M - L = O(M) \quad \text{Eq}\rightarrow 3$$

The energy required from source to destination SNs has to bebalanced and the path chosen should be optimal. A tree structure is used toillustrate how the path is completed between source and destination SNs. Atree begins its lifespan from the root SN and destines at the BS.This path is created by linking the intermediate SNs. Many remarkable kinds of research have been done in this aspect. Load balanced routesare devised in several techniques where BS is given highsignificance. The paths are constructed through the single path and multipathtechniques which were discussed in previous sections. The optimal path isselected for packet transmission every time at the end of the iteration. In everyiteration, the data is transmitted to the destination in a path with the idea of balancing the hectic workload of mediums. This is to ensure that no path isleft unused and no path is repeatedly used resulting in congestion. Changingthe direction of the flow of packets is also determined by the routing techniques.

(iii) Transmission of Data

The data transmission can begin only after the clusters are formedand the TDMA schedule is set. SNs will send the data during theirrespective allocated time for broadcast to the CH. It uses a nominal quantityof energy. Since the node cannot transmit the data other than its allotted time,the radio of every non-CHSN can be switched off, in this way the SNs minimize the energy dissipation. The same cannot be implemented for the CH node as it must keep its receiver on, to be ready to acknowledge allthe information. The CH node squeezes the information into a particularsignal by carrying out signal processing functions over the data. As thelocation of the base station is far away, it increases the consumption of energyfor transmission.

During the data transmission phase, the energy consumed by CH j, $F(CH_j)$ is evaluated utilizing Equation (4).

$$F(CH_j) = l(F_{ele} + \varepsilon nqe^4) + (n_j + 1)(l)(F_{Agg}) + n_j(l)(F_{ele}) \quad \text{Eq}\rightarrow 4$$

Examining Equation (4), the energy consumption rate includesthree parts: data transmission, data aggregation, and data reception. Thenetwork may contain several CHs near to the BS, while others mayremain far away. The energy consumed by far-away CHs for datatransmission is important, particularly in large-scale networks.Through this, an adaptive dynamic clustering route is formed to enhance energy efficiency.

4. Results and Discussions

The Ns2 simulator was used to test the proposed routing algorithm in which the battery module was utilized to build the SNs. The SNs are interactive and are periodically woken by a message from the individual CH. The sink SN is separated from the source SNs at the closest location. The higher-energy SNs will send a message and the other SNs will respond. Following the feedback from the neighboring SNs, the higher-energy SNs are set as the CH. Thus, the SN is allocated an id and therefore the target SN is set for packet transmission. For simulation, the route will be built using a suggested routing algorithm and path loss model. We have compared this proposed DOR protocol with the existing E-BEENISH protocol.

Network Model: The BS and the position of the SNs are fixed. The SNs are not considered immediately after the deployment. Due to the energy source (battery) cannot be recharged at this time. The available SNs have common abilities and importance. The SNs in the CR gather information by monitoring their surrounding area. For that case, the entire system is segmented into several clusters. The data gathering function of the SNs ensures that the SNs are from time to time monitoring the environment and transmitting the sensed data to the BS. It is the responsibility of the BS to investigate the received information to draw some conclusions about the happening around the surroundings.

The architecture of the system reflects the following:

- The sensor field has a fixed BS that is located far away.
- The energy constraint is allotted uniformly among all SNs at the initial stage.
- The environment is monitored by every SN at a specified time interval and at any given instance the SN has information to send to the BS.
- It is believed that the SNs are immobile.
- The SNs in the system have parallel computing and messaging ability.
- The real position of the SNs is not priory known.
- Based on the communication distance the transmitter can adjust its amplifier power for the signal to arrive at its target.

For a system representation that includes hundreds of SNs that are disseminated in a huge area. The WSN system senses data from SNs and transmits it to the BS, probably the network has only one BS with enough energy at a reachable distance from the SNs are taken into account. The role of SNs it senses the environment collect the data, and transmit the sensed data to its respective CHs, then the CH fuses the collected data into one single data and forwards it to BS. The SNs are affordable with high energy efficient as possible. Further, all the SNs and BS utilize frequent radio channels with a parallel communication range in the system. Table 1 shows the simulation parameters of the proposed WSN model.

Table 1. Proposed WSN architecture system parameters

Parameters	Values
Data aggregation energy	5nJ/bit
Data packet size	1024 bytes
Transmitter amplifier where $d < do$	10 pJ/bit/m2
Transmitter amplifier where $d \geq do$	0.0013 pJ/bit/m4
Node initial energy	0.5 J
Transmitter circuitry dissipation	50 nJ/bit
Network size	200 m ×200 m

The lifespan of a network: Two sub-parameters make up the network's lifespan: "Last SN Dies (LSND)" and "First SN Dies (FSND)," which are used to assess WSNs' functioning. If an SN goes down in the middle of collecting data, the regions it covers can no longer be monitored.

Number of SNs remaining alive:A WSN's data collection and sensing capacity may be maintained by determining the total number of actively running SNs in the network. The presence of active SNs in a WSN's context is significant to its credibility. WSN system functionality is evaluated by counting how many active SNs are in use in a given system.

The lifespan of the system: The lifespan of the system is determined by the LSND, FSND, or it may also be determined as the period where 50% of the SNs fail to function. So to increase the system’s lifetime, the time of LSND and FSND must be increased in a WSN system.

Residual Energy: The energy level of the SNs ensures SN lifetime. The RE isthe level remaining after the node has been deployed. Higher the RE, the longer the network lifetime.

4.1. Energy Efficiency

The percentage of the total transmission generated with the total energy consumed is termed energy efficiency. If particular data are transferred efficiently over a specified volume of energy, there will be a solution for energy efficiency increases. A wider term for energy efficiency is also termed "The use of less energy to deliver the same function may be defined as energy efficiency". In these contexts, energy efficiency is considered a principal parameterthat provides a higher precision of event detection with the same amount of energy consumption. Table 2 and Figure 3 demonstrated energy efficiency results using E-BEENISH and DOR. Here the DOR in transmission with various packet sizes in the WSN gives better energy efficiency.

Table 2. Energy Efficiency

Packet Size (Bytes)	E-BEENISH	DOR
20	90.32	96.43
40	81.23	92.32
60	72.56	88.78
80	63.54	84.12
100	54.65	80.12

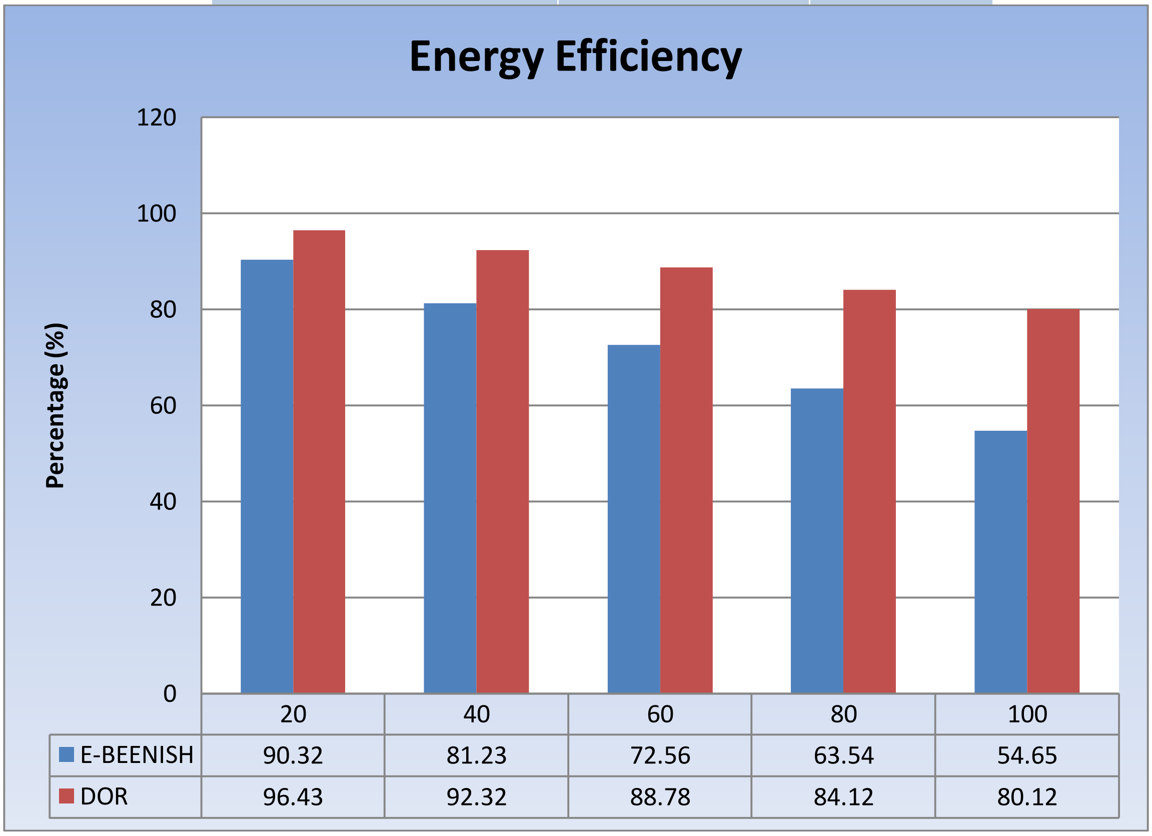

Figure 3. Energy Efficiency

4.2. Packet Delivery Ratio (PDR)

The PDR is the ratio of the number of packets sent to the destination successfully, to the sum of packets sent from the source. This metric demonstrates how a protocol should send packets to the respective destination. The high transmission ratio thus suggests improved efficiency of the protocol. Table 3 and Figure 4 demonstrated PDR output using E-BEENISH and DOR. When comparing E-BEENISH with a DOR by various packet sizes, the proposed DOR gives a better PDR.

Table 3. Packet Delivery Ratio

Packet Size (Bytes)	E-BEENISH	DOR
20	92.34	97.23
40	88.32	96.12
60	84.12	95.34
80	80.35	94.32
100	76.23	93.12

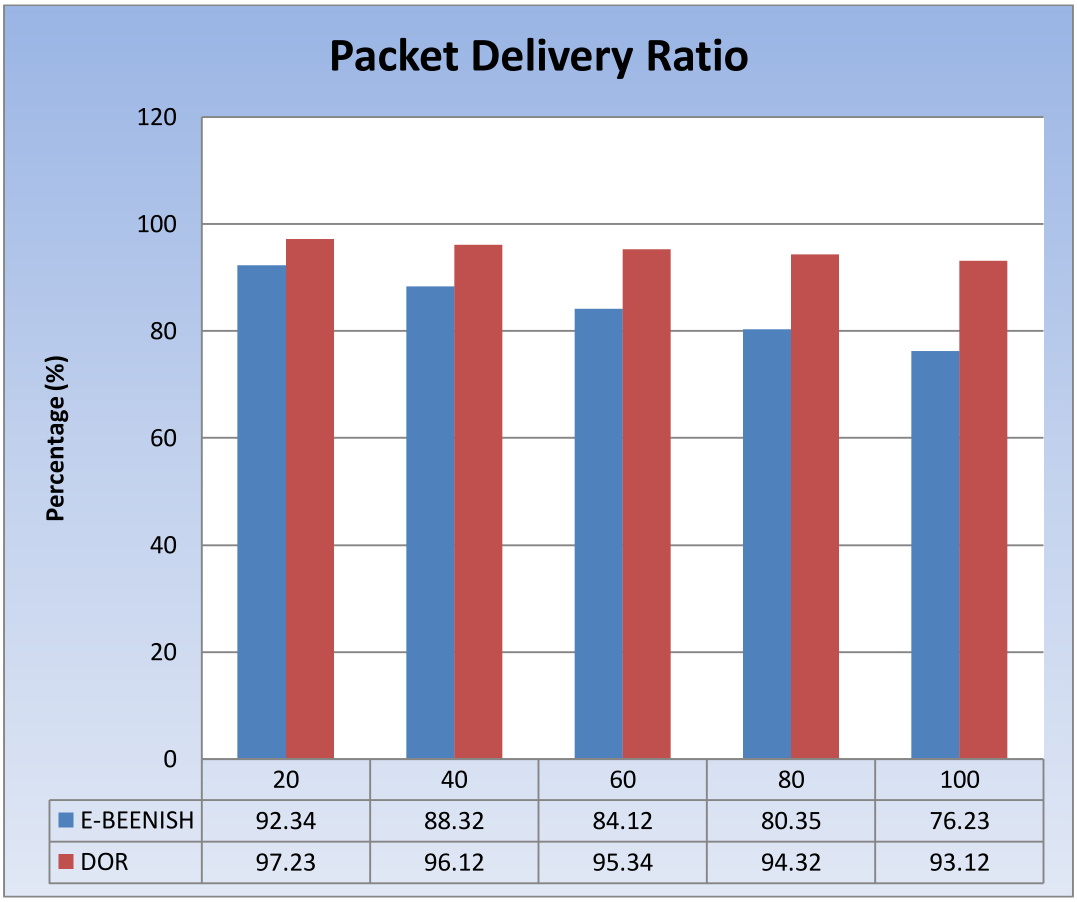

Figure 4. Packet Delivery Ratio

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4.3. Throughput

The throughput is also an important criterion for energy efficiency. The number of data units transmitted in a given time frame is indicated as a Throughput. This function allows us to measure accurately the volume of information transmitted. By considering the threshold levels in sensor nodes, the CH can be rotated to increase the performance and that helps to reduce the packet loss. Table 4 and Figure 5 give the level of throughput of E-BEENISH and DOR with various transmission rates. When comparing the proposed DOR provides a better throughput rate under any circumstance.

Table 4. Throughput

Transfer Rate (Kbps)	E-BEENISH	DOR
100	90.32	97.12
200	85.12	95.53
300	80.12	93.12
400	75.12	91.23

500	70.34	89.12

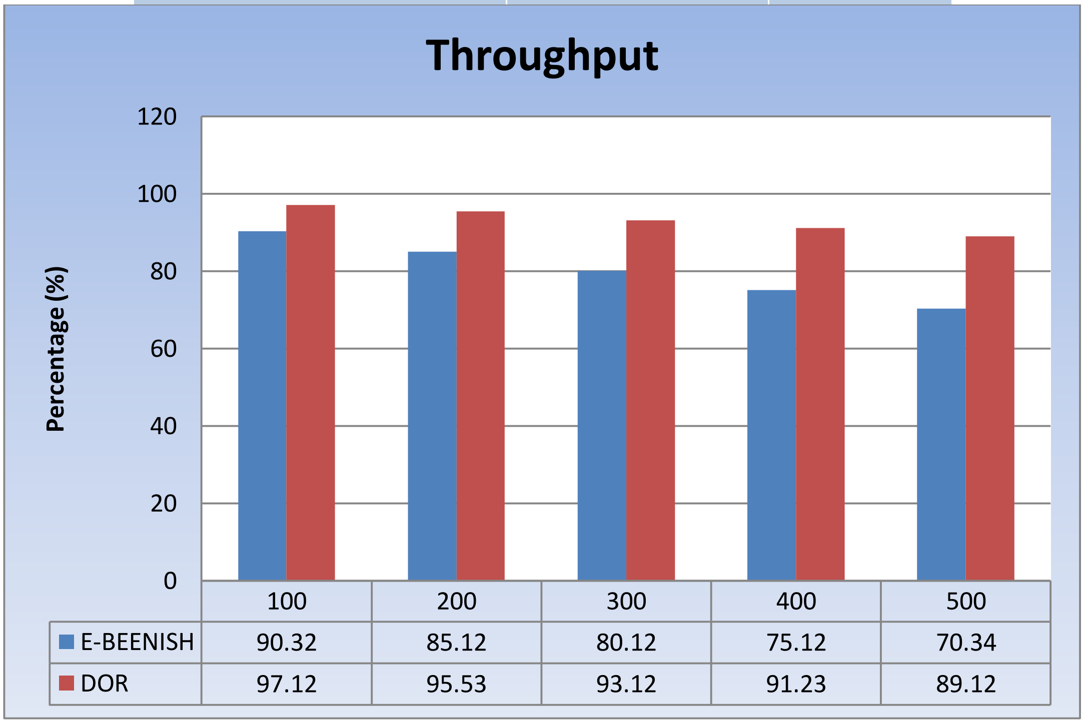

Figure 5. Throughput

4.4. Routing Overhead

Many nodes are interested in sending the packets from source to destination as node density grows. Thus, overhead routing grows as well. A path from source to destination is either influenced by an increase in node speed or by a delay. Once again, the construction of paths or path exploration must be begun to tackle the overhead routing. A large number of packet controls are needed in the protocol to retain the area size, pick the boundary nodes and modify the behavior. The routing overhead also increases with increased node capacity. Table 5 and Figure 6 show the efficiency of overhead routing with anE-BEENISH and DOR. Here the proposed DOR demonstrates low overhead routing while it is compared to E-BEENISH for different node sizes.

Table 5. Routing Overhead

Number of Nodes	E-BEENISH	DOR
200	20.42	5.12
400	32.42	8.34
600	48.21	14.21
800	68.22	23.12
1000	91.21	32.56

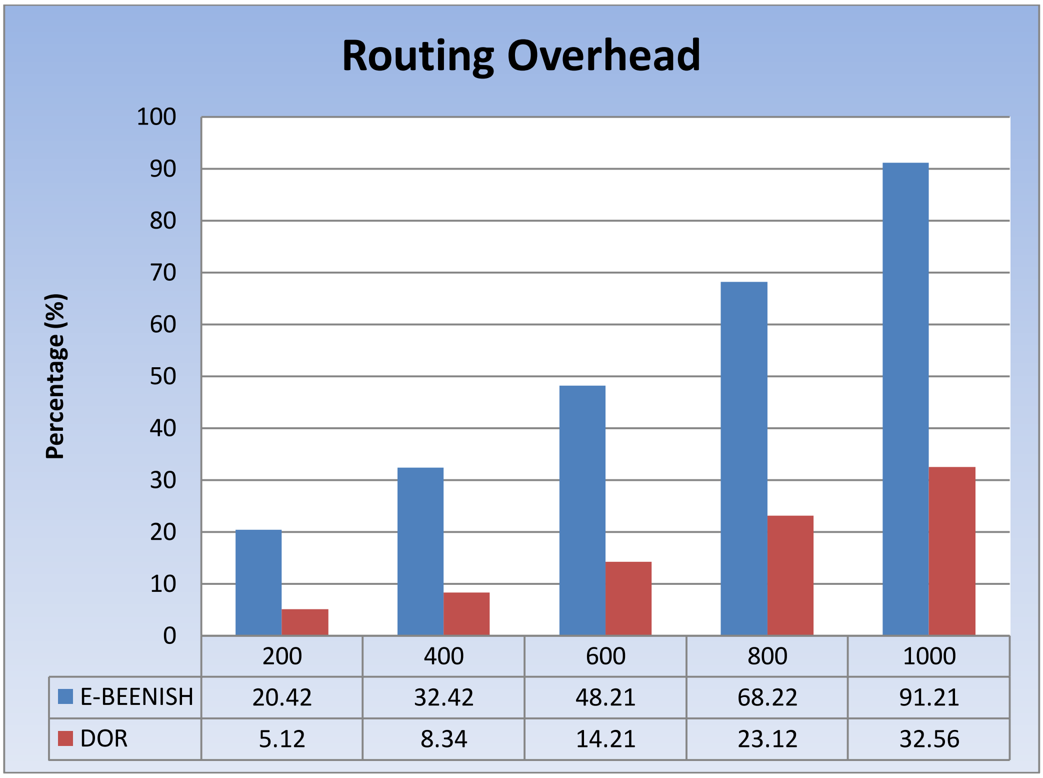

Figure 6. Routing Overhead

5. Conclusion

In an attempt to uphold the WSN system from energy degradation difficulties and extend its longevity, this research aims to provide a centralized approach for arranging SNs entities into clusters. Leveraging DOR-based clustering, an innovative and energy-efficient procedure for periodic data collection has been developed in this research. Its unique characteristics include managing energy consumption among CHs, preserving the energy consumption of SNs inside the cluster, and choosing the most suitable SN as a CH for the cluster. To improve the network's lifespan, we have introduced the DOR protocol. Using this method, the CHs may be selected depending on the situation of the whole network. The suggested DOR energy-efficient clustering algorithm outperforms the current E-BEENISH protocol concerning energy leveling and preservation. Results showed that an unequal clustering strategy improves network lifespan and balances energy consumption through an appropriate choice of CHs. In the future in the large-scale WSNs, for energy saving during data transmission among nodes the hierarchical routing using multi-hop the performance of information transmission can be raised as there is much scope over it.

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